Lesson 10 - B

Interdisciplinary Mystery

Using a Dinosaur Tracks to Understand Animals in an Ancient Environment

Summary

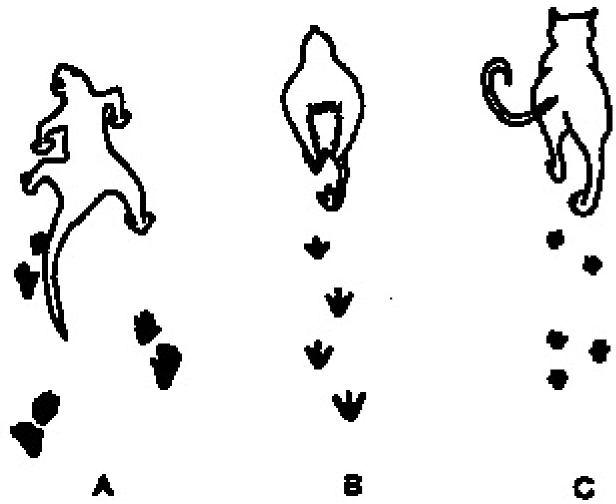
In this activity you will work with photos and drawings from a trackway found in the Hell Creek Formation in South Dakota and try to determine who made the tracks and how fast they were moving. You will also compare the South Dakota data with other track data.

Question 1

When animals walk they generally produce three different types of tracks.

A. A reptile's legs are directed out away from the body and move by its body laterally bending or flexing (Trackway A)
B. The bipedal gait of a bird or a human leaves a distinctive trackway with which we are familiar (Trackway B).
C. A mammal has its legs directly beneath its body and swings each leg in an anterior-posterior direction (Trackway C).

Because the legs of a dinosaur are beneath the body, bipedal dinosaur foot prints would be like a human or a bird, and quadrupedal dinosaurs would be like a cat or an elephant.



Trackways of living animals.
(Redrawn and modified from Alexander, 1989)

1a. Looking at these two photographs, what type of animal do you think produced these tracks?

"Track one" shows the tracks in plaster casts, which the paleontologists used to protect the tracks when they were dug up and removed for further study in a scientific lab.

"Track two" shows the tracks in place, in sandstone, after they have been cleaned up a bit.

a. Lizard
b. Mammal
c. Bird
d. Dinosaur

1b. Why do you think this?

Bipedal gait is characteristic of birds and dinosaurs.

Question 2

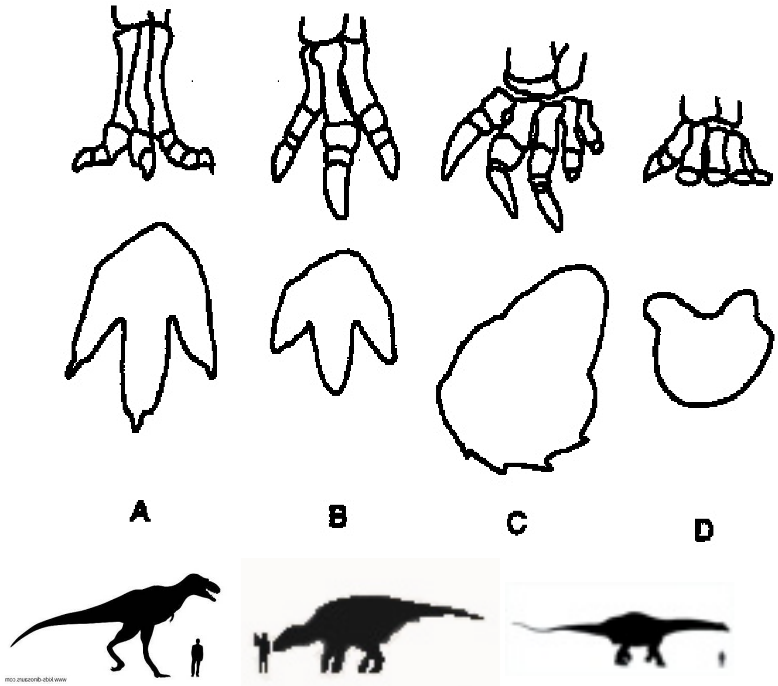
2a. Where did this trackmaker live? (Think about what type of rock the tracks were preserved in, when and where you have seen tracks (human or animal), and what type of environment they were in. Would that have been a good place to preserve them?)

a. In a sandy desert, where winds blew regularly.
b. Near a fast moving river where water washed away sediments.
c. A river flood plain or muddy beach, where fine-grained sand and silt slowly accumulated.
d. Sandy beach near a sea, where waves constantly washed ashore.

2b. Why do you think this?

In other environments, tracks would have eroded away before they could have been preserved.

Question 3



Foot bone structure and typical footprints of three dinosaurs shown at left
(redrawn and modified from Alexander, 1989 -- scale of dinosaurs relative to a person)

A. Hind foot of *Tyrannosaurus* **B.** Hind foot of *Iguanodon*
C. Hind foot of *Apatosaurus* **D.** Fore Foot of *Apatosaurus*

Dinosaur feet had three or five toes. Theropods and many bipedal ornithischians had long toes (Figures A and B), so that a three-toed or triangular footprint was made. Alternatively, the large sauropods probably had massive legs and more rounded, more flat-bottomed feet like those of an elephant with five short toes (Figures c and d).

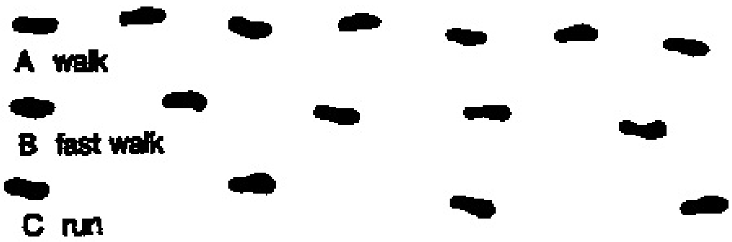
3a. - Looking at single track photograph (Track Three), what type of dinosaur made this track?

a. Theropod
b. Sauropod

3b. Use the life sized track photograph (Track Three) to determine how long the animal's foot was. *Note that the scale in the photo shows centimeters (shorter black bars) and inches (longer black bars). Also, note that you do not want to measure the additional narrow part at the end of the middle toe.*

How big was it? __40-50 cm depending on how you measure the track__

Question 4



Speed can be determined by looking at a trackway because stride length is positively correlated with speed, i.e., as speed increases stride length increase

Notice how human tracks change as speed changes. (Redrawn and modified from Alexander, 1989)

Step by step process to determine speed of animal at the *Wakangi styxi* site.

4a. What was the *foot length* of the animal in the trackway (use foot length from question 3). 45 cm

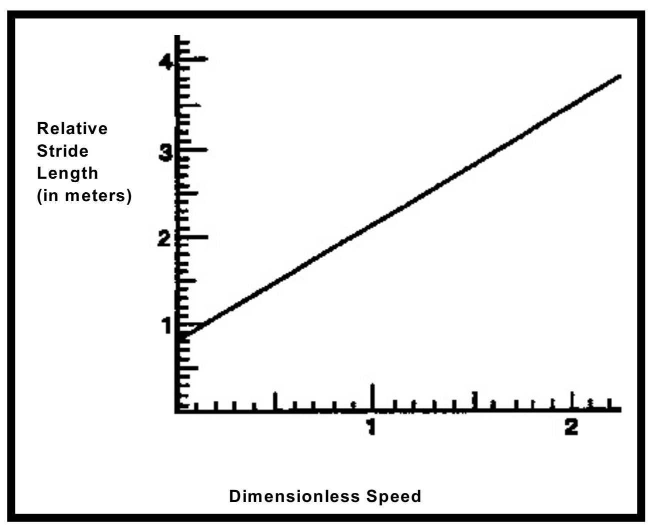
4b. What was the *stride length* of the animal in the trackway. Use average heel-to-heel measurements in CM from drawing of *Wakangi styxi* site to find a stridge length. 150 cm

4c. Calculate the *leg length* by multiplying "foot length" by 4. Leg length gives you an idea of how tall the animal was as it shows the height of the animal at its hip.

(*Foot length*_45 cm____) X 4 = *Leg length* _180 cm___

4d. Calculate the *relative stride length* by dividing the *stride length* by the *leg length*.

(*Stride length*_150cm__)/(*Leg length*__180cm______) = *Relative stride length* _____.833_________



4e. Use the figure to the right to determine the *dimensionless speed* from the *relative stride length* that you calculated above. If the relative stride length is less than 0.9, use 0.1 for the dimensionless speed.

Dimensionless Speed = ___.1___

4f. Using appropriate values determined above, calculate the dinosaur *speed* using the following equation, where gravitational acceleration is 10 meters per second - squared (10 m/sec^2) The calculated dinosaur speed will be in meters per second.

Speed = (*dimensionless speed*) X (square root of (*leg length* X *gravitational acceleration*))

= .1 x (sq rt (1.8m x 10 m/sec^2))
= .1 x (sq rt (10.8 m/sec))
= .1 x 3.28 m/sec
= .328 m/sec
= .733 mph

4g. Based on how tall the animal was, describe how fast the animal was moving. Examples might include trotting, running, moseying, walking, galloping, sprinting, or a stealthy and quiet walk.

It was probably walking along slowly, perhaps hunting.

Question 5

Determine the speeds of at least two dinosaurs from each category.

	Stride Length (meter)	Leg Length (meter)	Speed
Meat Eaters			
Tyrannosaurus	3	2.1	
Allosaurus	3	2	
Megalosaurus	1.3	1.1	
Velociraptor	2.7	1	
Plant Eaters			
Apatosaurus	2.5	3	
Apatosaurus	1.6	1.5	
Hadrosaur	4.2	3.4	
Stegosaurus	1.9	1.4	

5a. Which dinosaurs could you outrun?

Generally could out run plant eaters.

5b. Which group ran faster?

Meat eaters were generally faster.

5c. What can you infer about the predator-prey relationships between meat and plant eaters?

Predators used their speed to catch their prey.

5d. How did meat eaters capture their prey?

Used their speed and perhaps surprise as well. The second part of this answer does not come from information you could glean from this activity but students may bring in this information from previous knowledge.

5e. How did plant eaters avoid being captured?

They could be too big to eat, have protective body parts, hide, stay in packs. The last three answers do not come from information you could glean from this activity but students may bring in this information from previous knowledge.